Microbial Response to Deep Peat Heating

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Boreal peatlands cover 3% of the earth's surface and contain 1/3rd of the planet's terrestrial carbon stores. As temperatures rise, northern bogs are expected to release more carbon, fueling greater warming. To examine the role of microbial decomposition in the surface of boreal bogs, we monitored extracellular enzyme activity at the Spruce and Peatland Responses Under Climatic and Environmental Change (SPRUCE) experiment in the USFS Marcell Experimental Forest. Carbon-, nitrogen- and phosphorus-degrading extracellular enzymes were measured in a peat heating experiment, where peat at 2 m was warmed as much as 9 °C above ambient temperatures. Two replicate plots were sampled for each heating treatment. Samples were collected when warming began in June 2014 and again in September after 100 days of warming. Potential activity of nine extracellular enzymes was quantified at 0-10, 10-20, and 20-30 cm below the peat surface for each sampling date.

Greatest enzyme activity was in phosphorus > carbon > nitrogen-acquiring enzymes (acid phosphatase > beta-glucosidase > N-acetylglucominidase). Generally enzymatic potential was higher in the surface (0-10 cm) and decreased with depth (and increasing moisture). When assessed *in situ*, nitrogen-acquiring enzymes of microbial populations were more sensitive to deep peat heating than carbon- or phosphorus-liberating enzymes. Aminopeptidases were sensitive to warming at 10-20 cm below the peat surface in plots warmed +4.5 °C at depth. Median enzymatic potential for leucine aminopeptidase was 11 times greater in warmed plots than in ambient plots. Similarly, median alanine aminopeptidase potential 10-20 cm below the surface was 4 times greater in warmed plots than in controls. Peptidases contribute to both carbon and nitrogen cycling. Peptidases depolymerize proteinaceous material to liberate amino acids, which can be directly assimilated by both plants and microbes. Peptidases have been identified as the main enzymes involved in short-circuiting the N mineralization pathway, thus supporting the rapid cycling of organic N, particularly in N-limited ecosystems. Our results suggest that peptidases may be particularly sensitive to ecosystem shifts in temperature. Therefore, increased peptidase activity with warming could alter N availability, and in turn alter plant and microbial productivity. Increased organic N cycling in response to warming may be harbingers for longer-term plant community responses and the ecosystem C budget, which will be assessed with future sampling of the SPRUCE experiment.